

Worldwide Satellite Weather Information Service

**May 23, 2000
Hampton , VA**

Outline

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Overview

- ⌘ In-service evaluation of real time graphical weather information on flight deck
- ⌘ Provide updated graphical weather to pilots while enroute for strategic flight decisions
- ⌘ Trials to quantify safety benefits, verify commercial feasibility
- ⌘ End solution is to provide wide area coverage for all classes of aircraft

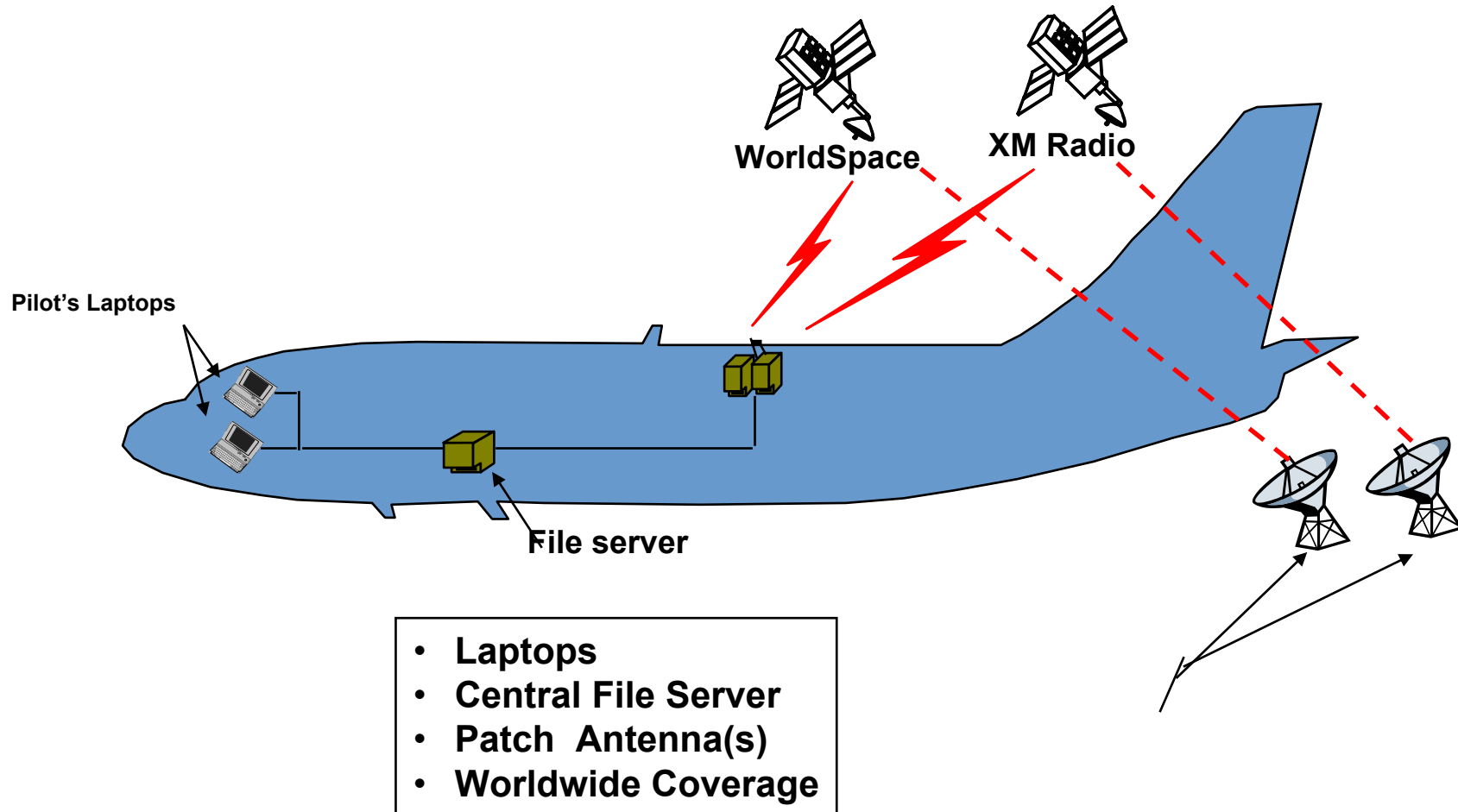
In Service Evaluations

- ⌘ Phase 1, Installed on single engine aircraft**
- ⌘ Phase 2, Install on 2 revenue service Air Transport Aircraft**
 - Transoceanic routes**
- ⌘ Phase 3, Install on 6-15 aircraft, all types**
 - Additional transcontinental routes**
 - CONUS operations**

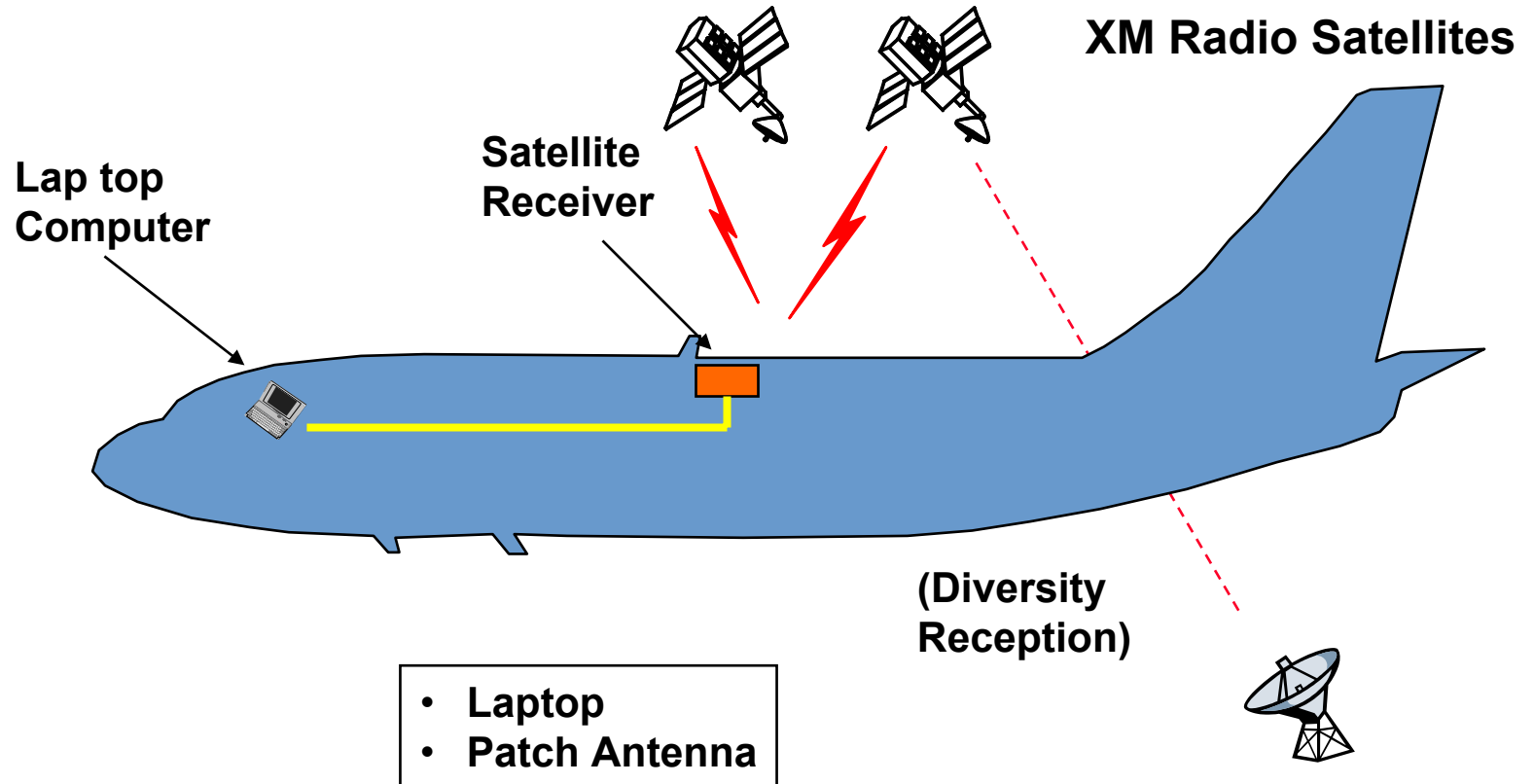
Program Phases

- **Phase 1.** Verify that geostationary satellite can provide a sufficient signal level to aircraft using a fixed pattern antenna.
 - Trials in South Africa in September, 1999
 - Cessna 182 aircraft, Afristar satellite
- **Phase 2.** Validate the usefulness and pilots preferences of real time weather data
 - Routes to the Pacific rim with American Airlines,
 - Trials beginning in November 2000, using AsiaStar satellite
- **Phase 3.** Extend trials to include Air Transport, Business, and General Aviation in USA and South America
 - XM radio satellite, March to October 2001.
 - Ameristar satellite, May to October, 2001

Air Transport Phase 2 and 3 System Configuration



Business and General Aviation Phase 3 Conus System Configuration



Wide Area Coverage

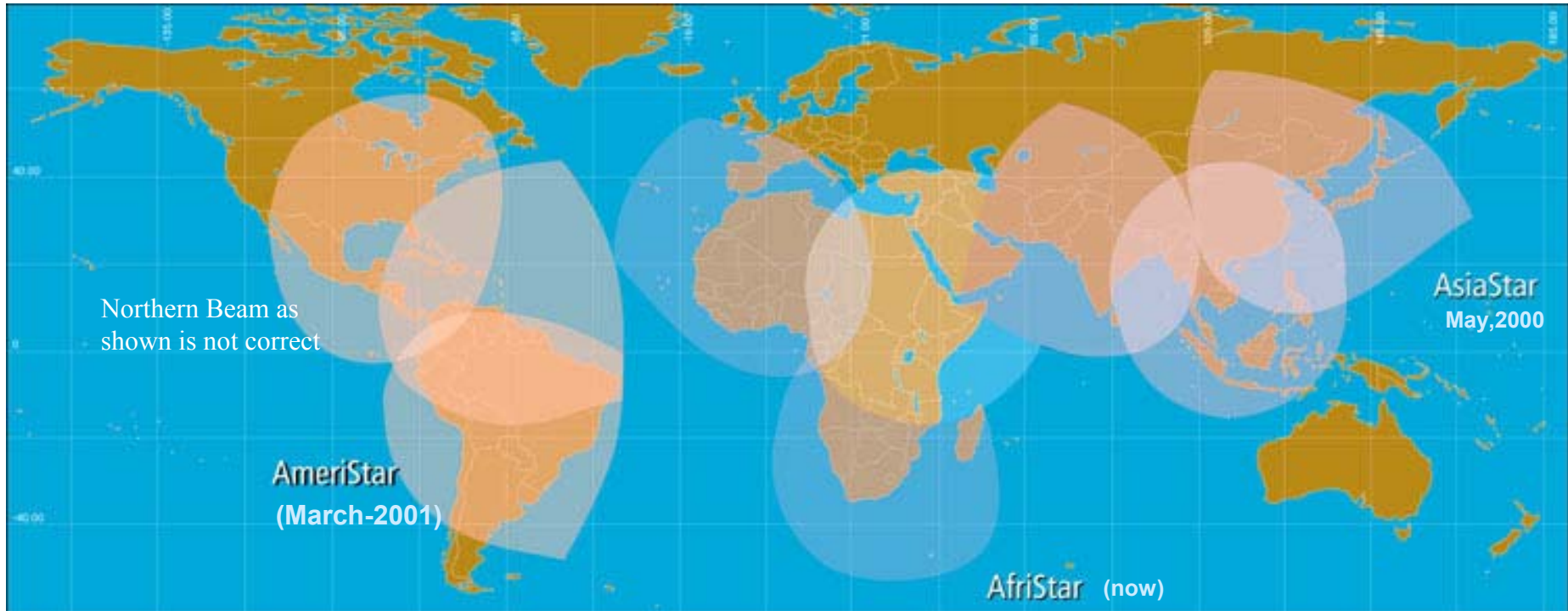
WorldSpace satellites located at:

- ☒ Africa (now), serves entire Africa and some Europe
- ☒ Asia, (now) all of Pacific rim from Korea through Malaysia China and Eastern Russia, India, etc.
- ☒ Central America (2001), Serves S. American and Caribbean

XM Satellites located at 85 and 115 degrees W

- ☒ Will serve Conus (November, 2000 and March 2001)

WorldSpace Coverage Areas



(NOTE: AmeriStar footprint shown pending frequency coordination outcome)

- 80 percent of the world's population
- 120 countries
- 3 continents

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Phase 2 Team Members



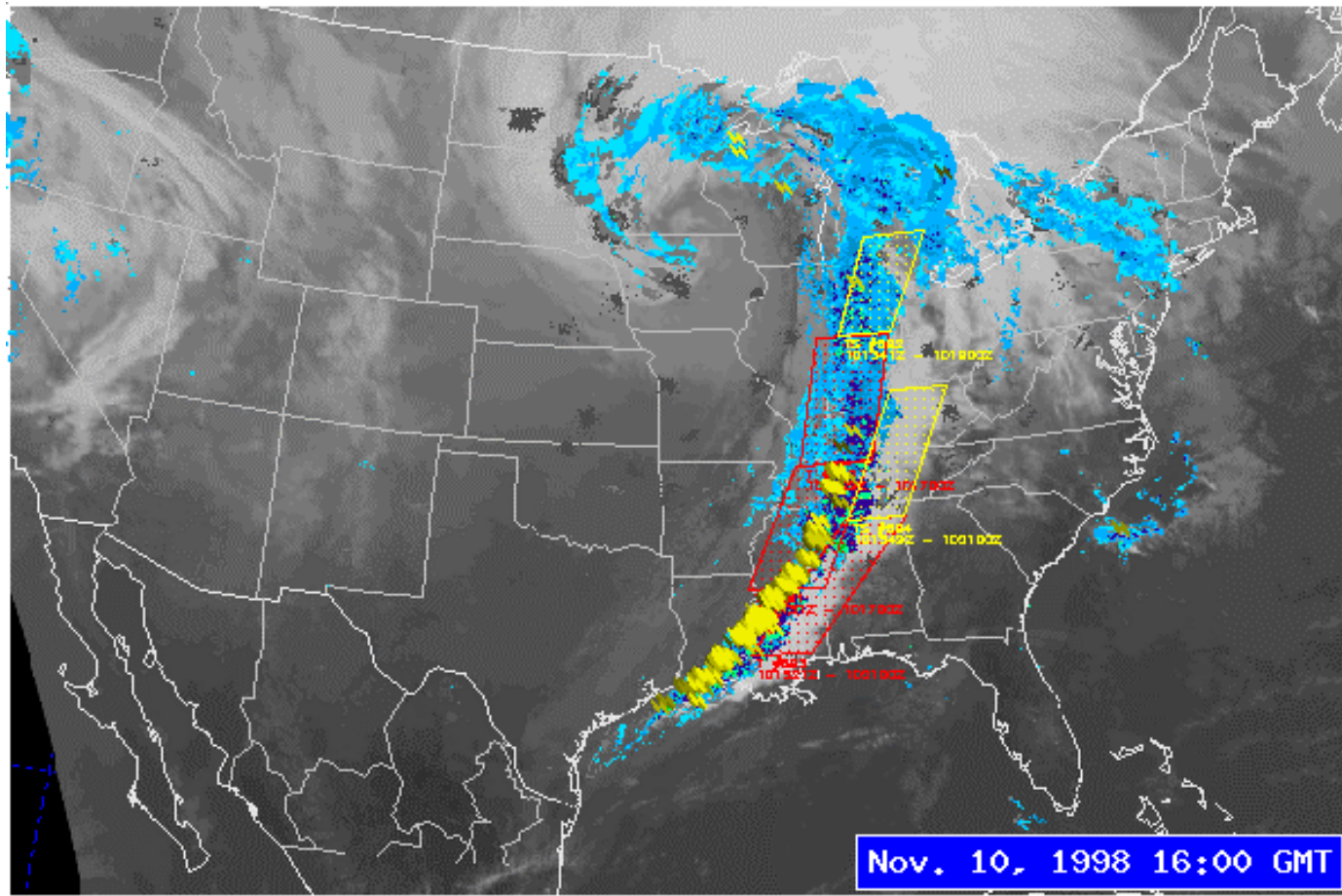
- System Integrator, Hardware Provider, Test, & Certification, Data Storage, Displays, Receiver development, Antennas, Integration, STC costs
- Asiastar satellite channel, receiver boards, ground station feed
- Two Boeing 777 Aircraft
- Weather data provider, Display Application software
- Financial Support, Antenna Verification, Consultation & Testing
- N. Pacific ONCD Data



Additional team Members for Phase 3

- **XM Radio:** XM Radio will provide Satellite data link for CONUS operations, 2000-2001
- **NBAA :** Expressed desire to participate in Phase 3, offered business aircraft for trials, to use both WorldSpace and XM Radio data links
- **EAA:** Expressed desire to participate in Phase 3 using XM Radio link and to demonstrate low cost implementation to their members.
- **WSI:** Agreed to provide additional Weather Graphics

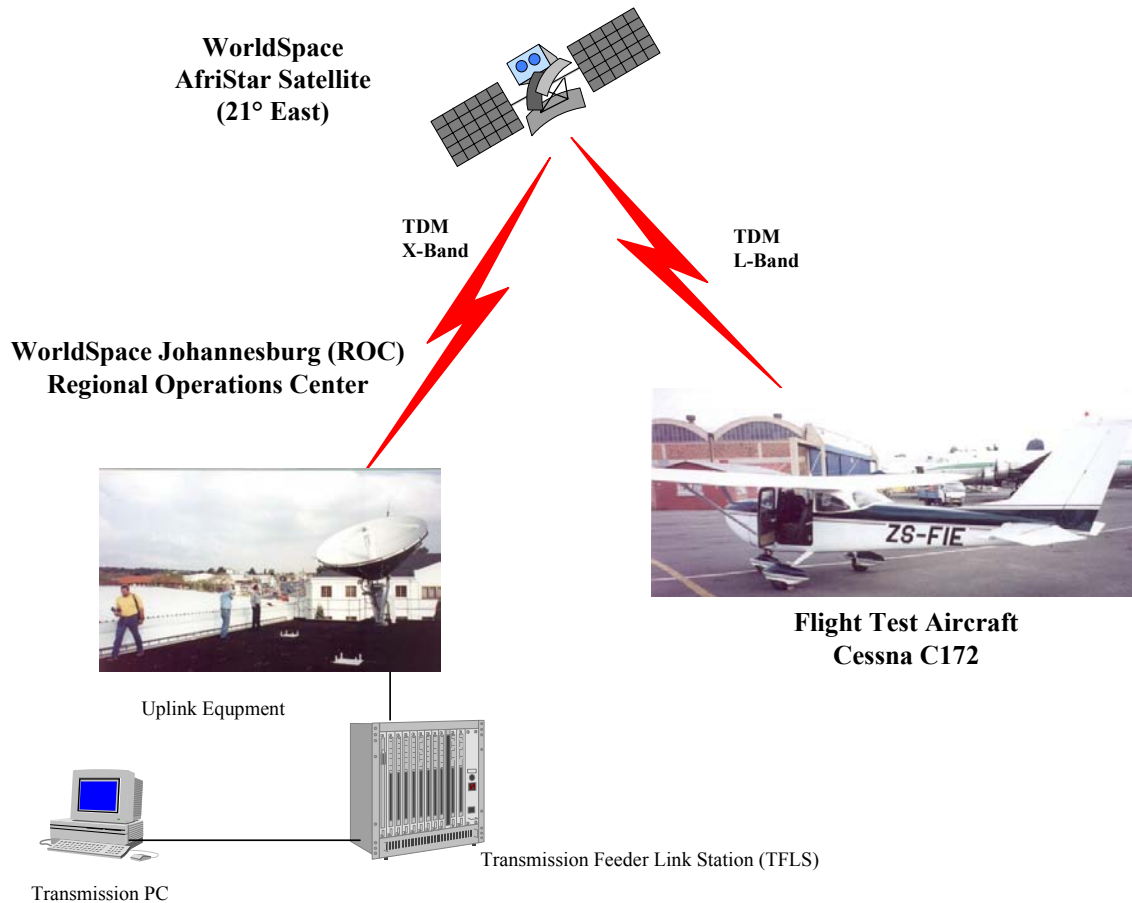
Superior Pilot Interface



Jeppesen Enroute Maps with Weather Overlays

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Phase 1 System Description



Phase 1 Objectives

- Validate that a fixed “patch” antenna can receive Satellite broadcasts reliably.
 - Determine link margin
- Determine limit of aircraft dynamics to reliably receive the signal without errors

Phase 1 Results

- **Flight tests in Johannesburg S. Africa**
 - September, 1999
 - Afristar South Beam
 - User data rate was 64 Kbits/sec
 - Cessna 172 Aircraft Equipment:
 - Patch antenna
 - Hitachi “Boom box” receiver
 - SPCA digital adapter
 - Lap top Computer
- **Flight Tests Very Successful**

Phase 1 Test Results

Bank Angle	Reception	Comments
17.5 deg	100 %	OK
30 deg	100 %	OK
45 deg	100 %	OK
50 deg	100 %	Hdgs 80-230 deg to Satellite
60 deg	100 %	Hdgs 70-270 deg to Satellite
50-55 deg	unlocked	Hdgs 80-230 deg away from Satellite
60 deg	unlocked	Hdgs 70-270 deg away from Satellite

Phase 1 Details



WorldSpace
SPCA



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Phase 2 Objectives

- Develop weather data graphics for North Pacific and Eastern Asia routes
- Install satellite ground stations at Narita and Hong Kong and weather station at Chicago.
- Install equipment on Revenue Service Aircraft
 - Obtain metrics on improvements of flight safety
 - Obtain metrics related to economic benefits
- Transmit weather data to aircraft via the Asiastar satellite
- Develop ground network capability to rapidly move new graphics files to airborne aircraft. (few seconds)

American Airlines

- ⌘ An air carrier was needed to evaluate commercial viability.
- ⌘ American Airlines was willing to modify aircraft and evaluate candidate graphics.
- ⌘ American has particular interest in adverse weather.
 - ☒ Early flight change decisions based on weather data leading to:
 - Higher on-time arrival rates
 - Improved fuel savings
 - More comfortable ride to passengers
 - ☒ Better weather data for remote routes such as South America and Pacific routes
- ⌘ Enhance flight safety
 - ☒ Reduce number of injuries due to unexpected turbulence.
- ☒ **American Airlines is providing two B777 aircraft for Phase 2, additional aircraft for Phase 3.**

Phase 2 Implementation

- Trials supports routes from Chicago to Narita and Hong Kong.
- Jeppesen providing weather graphics and display software
- Rockwell providing File server, WLAN , laptops, data mgt software.
- WorldSpace providing 64 kb/sec user data rate for 6-8 month period.

Phase 2 Details

⌘ Antenna

- ☒ Is “fixed pattern patch style”,
 - No steered beam antennas

☒ Receiver

- ☒ Uses WorldSpace receiver repackaged for Avionics environment
- ☒ Collins is providing 100 % of certification funding
- ☒ Collins is in process of qualifying all equipment

Phase 3 Objectives

- Provide satellite weather information to all aircraft
 - 5 minute NEXRAD, graphical METAR, SIGMETs, etc
 - USA data link will be provided by XM radio.
 - Complete CONUS coverage
 - S. America data link will be provided by WorldSpace
- Design and build a number of receivers.
 - System design for appropriate installations.
- Support certification efforts for selected aircraft.
- Select candidate aircraft for installation
- Develop metrics for evaluation
- Collect and analyze data, generate interim and final reports

Phase 3 Operations

- In USA, data will be delivered to a wide variety of aircraft types
- Candidate aircraft will agree to provide detailed data and FOQA data as appropriate.
- Additional American Airlines A/C will be equipped

Phase 3 Implementation

- **Antenna** for XM Satellite will be “patch antenna”, designed for aircraft, for (2320 MHz Band), i.e., No steered beam antennas
- **Receiver** will use XM receiver components, and build receiver for Avionics environment.

Collins will build LRU and add RS232 and/or ARINC 429 interface.
Collins will qualify LRU to DO-160C as appropriate

STCs: Business and air transport aircraft will be STC'd by Collins
STCs for aircraft types: B757 and B767, definite, B737 possible
Other aircraft types under review.
Equipment for general aviation will not be TSO'd or STC'd.

Air Transport and Business aircraft may have two receivers and dual antennas to receive both WorldSpace and XM satellite data.

Transfer time

<u>Receiver</u>	<u>Signal rate Kbps</u>	<u>10 K NEXRAD file</u>
Satcom AERO-H	4.2	19 sec
VDL M2	31.5 (24 net)	3.3 sec
WorldSpace32	78 (32 net)	2.5 sec
WorldSpace 64	156 (64 net)	1.25 sec
XM Radio	32	2.5 sec

Broadcast Satellite Advantages

- Higher data rates than Inmarsat, VDL- M2 or FIS-B.
- Wider area coverage than FIS-B.
- Lower cost per Kbyte than all two way data links.
- Large variety of weather information will be available.
- Reception available on the ground, everywhere !!
- Data usable by all segments of the aircraft community
- Dual systems of XM and WorldSpace provide wide coverage area